



Supplement of

Stability of ENSO and its tropical Pacific teleconnections over the Last Millennium

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Supplementary Figure Captions

Supplementary Figure 1 Comparison of leading patterns (standardised, first EOFs) of monthly variability in surface temperature for CMIP5 multi-model mean (MMM) for (a) historical and (b) Last Millennium experiments. The location of the NINO3.4 region (5°N - 5°S, 170° - 120°W) is indicated by a rectangular box.

Supplementary Figure 2 Wavelet analysis of simulation of the Last Millennium with bcc-csm1-1 model, showing erroneously biennial ENSO spectral power showing (a), Morlet wavelet coefficients shown by colours ranging from white (weak) to deep red (strong), with the contours enclosing regions of greater than 95% significance level. Colourbars are omitted since units are arbitrary. (b) Global mean NINO3.4 power spectrum ($K^2/\text{unit frequency}$, black), relative to the red-noise (AR(1)) benchmark (dashed).

Supplementary Figure 3 Evolution of prescribed volcanic forcings for CMIP5 Last Millennium experiment, showing the two alternative data sets used by modelling groups, including (a) timeseries of stratospheric aerosol optical depth (AOD) at 0.55 μm provided by Crowley et al. (2008) and (b) global hemisphere total stratospheric injections (Tg) from Gao et al. (2008). Large volcanic eruptions occurring between 1200 and 1500 are evident in both data sets.

Supplementary Figure 4 Evolution of total solar irradiance (TSI, W/m^2) for CMIP5 Last Millennium experiment, showing the two of alternative data sets available for use by modelling groups as a forcing. Datasets shown as examples are the Steinhilber et al. (2009) extension to the Wang et al.'s (2005) reconstruction (a) and the Krivova et al. (2010) reconstruction (b). Other reconstructions are available for use as a forcing.

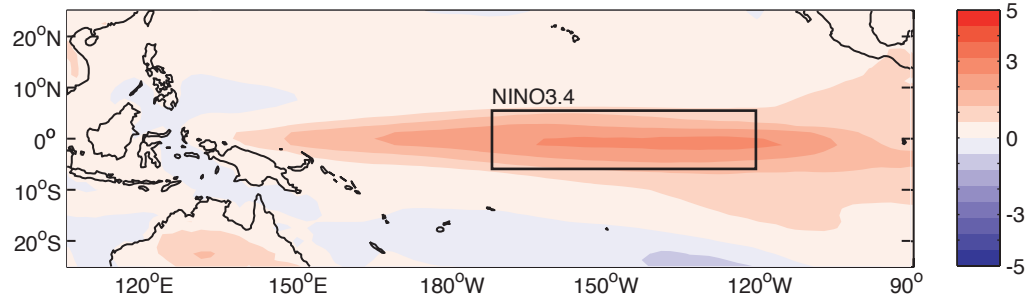
Supplementary Figure 5 Wavelet analysis of simulation of the total solar irradiance (TSI, W/m^2) for CMIP5 Last Millennium experiment showing (a), Morlet wavelet coefficients shown by colours ranging from white (weak) to deep red (strong), with the contours enclosing regions of greater than 95% significance level. Colourbars are omitted since units are arbitrary. (b) Global mean NINO3.4 power spectrum ($K^2/\text{unit frequency}$, black), relative to the red-noise (AR(1)) benchmark (dashed). Wavelet analysis is shown for the Steinhilber et al. (2009) (upper) and Krivova et al. (2010) reconstructions (lower) as example.

Supplementary Figure 6 (a) NINO3.4 mean wavelet power spectra, generated using the Morlet wavelet (Torrence and Compo, 1998) for MMM for historical (black), past1000 (blue) and midHolocene (red) experiments. For each experiment, the 90% significance levels are shown by dashed lines and the grey box indicates the ENSO 2–8 year band. Also shown are composited anomaly maps for surface temperature (K) for CMIP5 models for (b) El Niño and

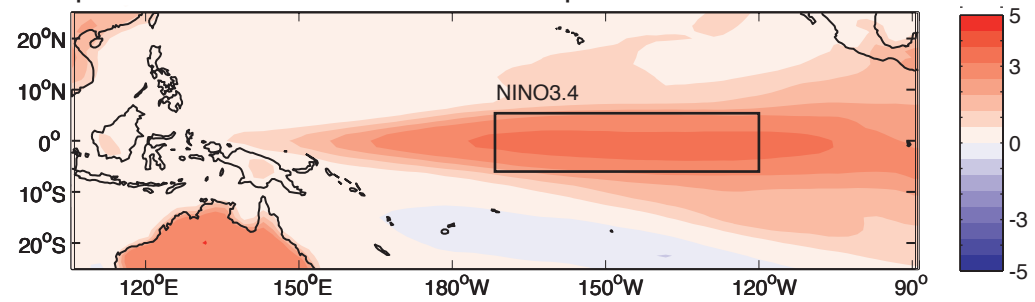
(c) La Niña episodes in the mid-Holocene experiment. Rectangular boxes indicate the East, Central and West Pacific regions.

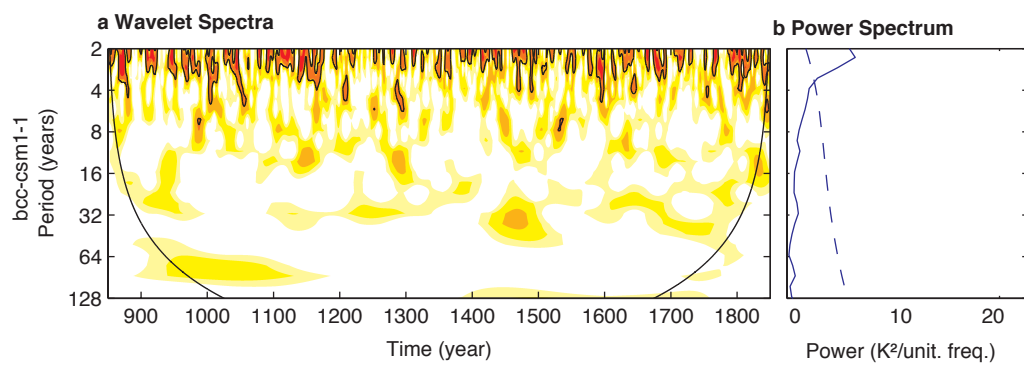
Supplementary Figure 7 Scatter plots of mean surface temperature anomalies (K) in the NINO3.4 region against West Pacific area-mean surface temperature (a) and precipitation (b) anomalies. Data points are shown for the historical (grey), past1000 (blue) and midHolocene (red). Lines of best fit are calculated for each experiment using ordinary least squares regression. Also shown are histograms of the distribution of simulated monthly surface air temperature (K) and precipitation (mm/day) anomalies for West Pacific region for El Niño (c) and La Niña episodes (d) for the historical (grey), past1000 (blue) and midHolocene (red) experiments.

a Historical MMM EOF1 surface temperature

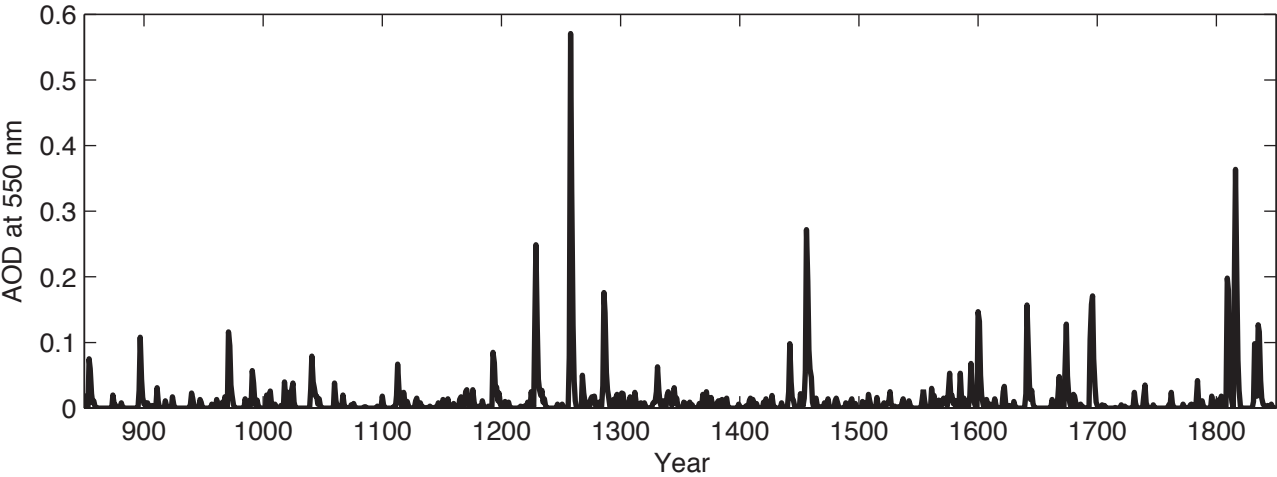


b past1000 MMM EOF1 surface temperature

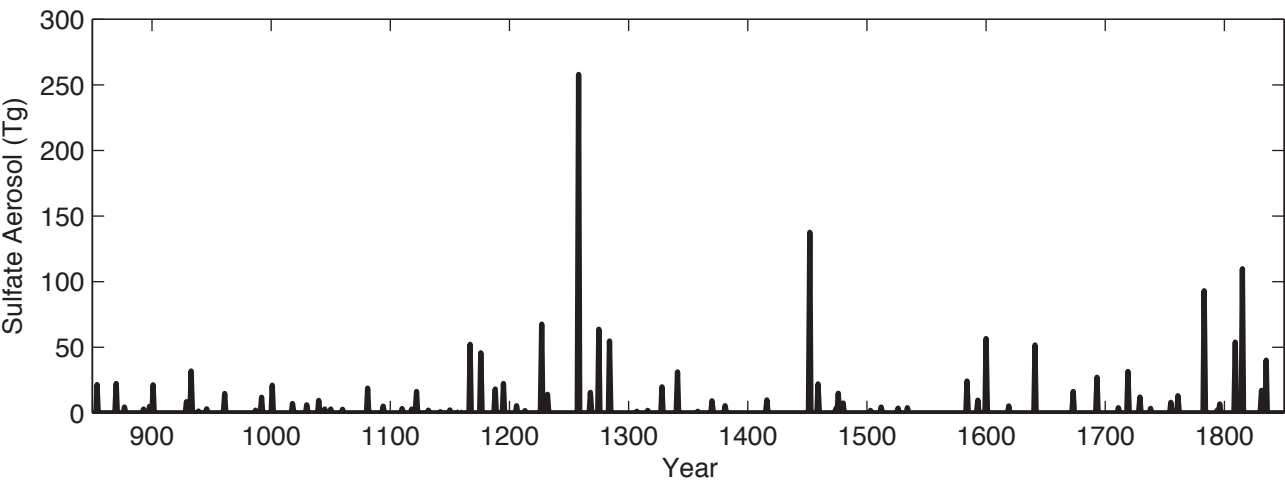


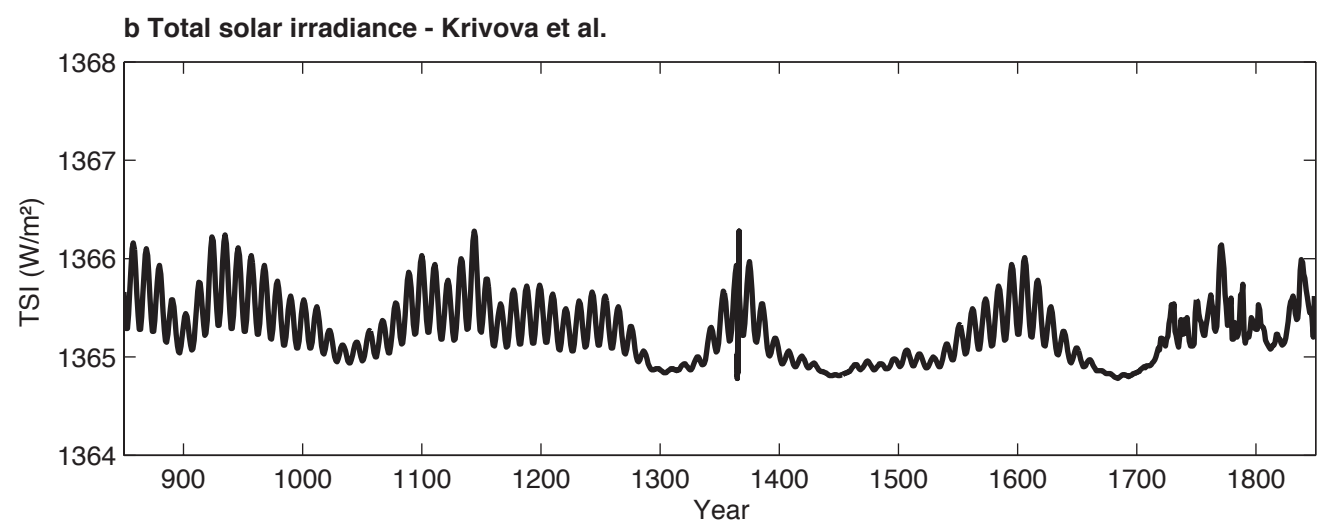
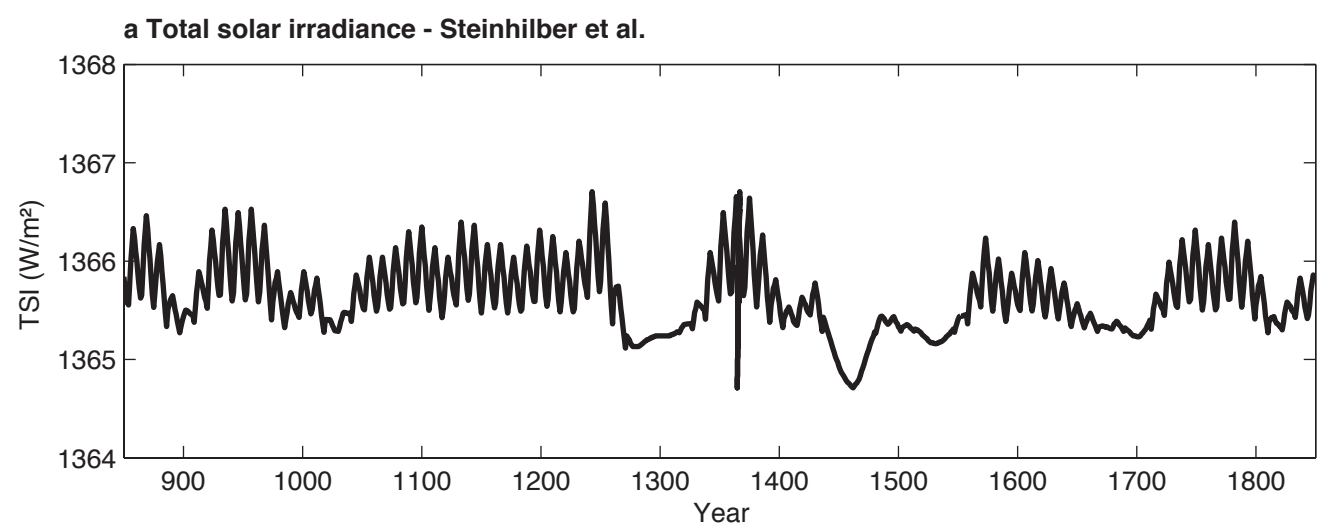


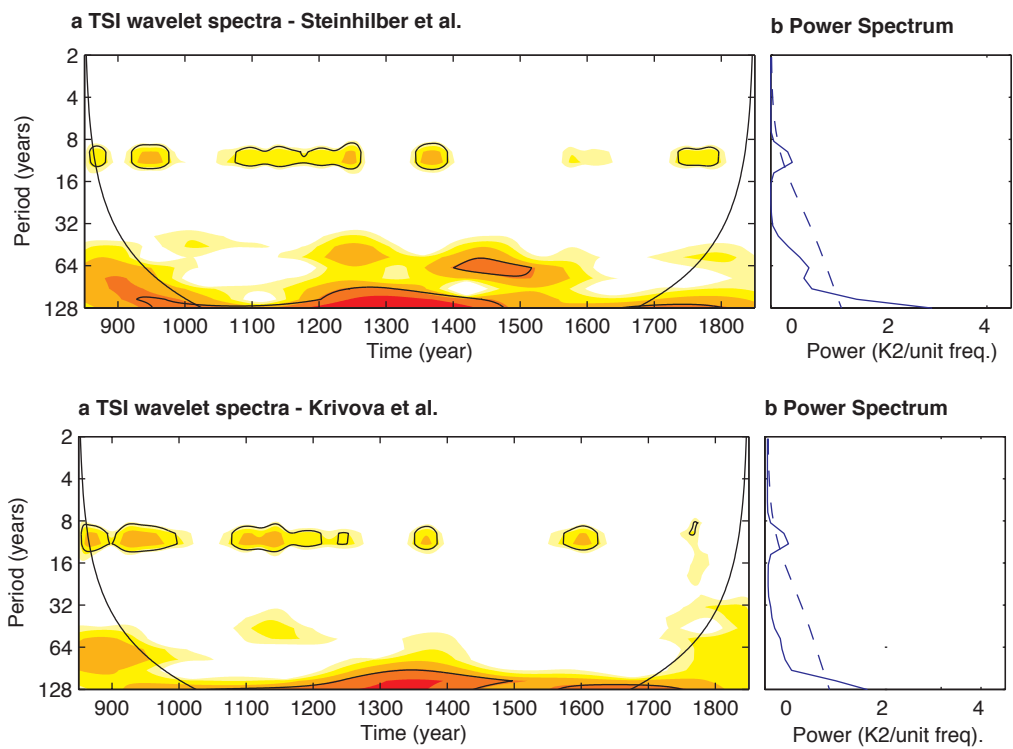
a Stratospheric aerosol optical depth - Crowley et al.



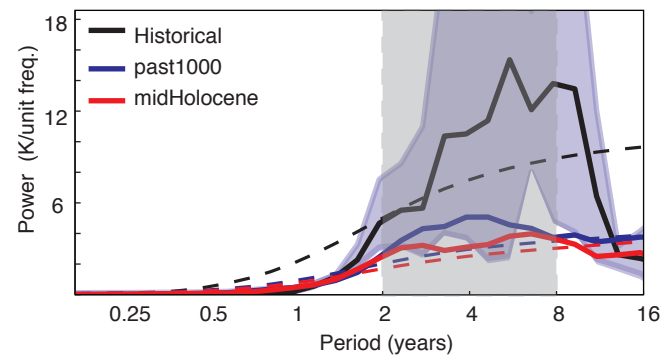
b Stratospheric aerosol injection - Gao et al.



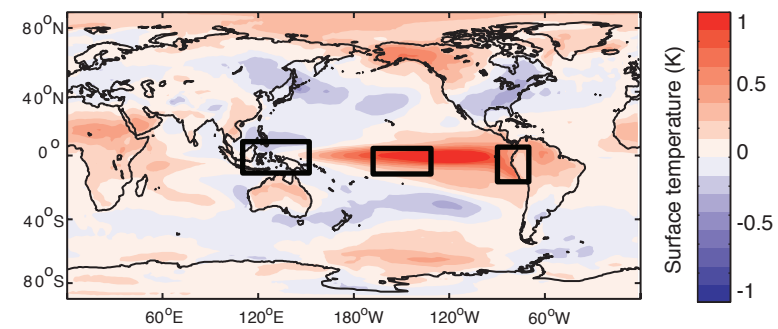




a MMM Power Spectrum



b mid-Holocene El Niño composite



c mid-Holocene La Niña composite

